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Geology and Mineral Potential of the Puzzle Lake Area, Central Metasedimentary Belt, Grenville Province

2001

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ONTARIO GEOLOGICAL SURVEY

Open File Report 6064

Geology and Mineral Potential of the Puzzle Lake Area, Central Metasedimentary Belt, Grenville Province

by

R.M. Easton

2001

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Contents

Abstract ix

Introduction 1
Previous Work 2

Geology 3
Overview 3
Mazinaw Domain 4
Sharbot Lake Domain 4
Greenstone-Granodiorite Package 5
Marble-Syenite Package 8
Hinchinbrooke Pluton 10
Robertson Lake Mylonite Zone 11

Economic Geology 12
Overview 12
Moderate to High Potential for Zinc, Molybdenum and Wollastonite 13
Low to Moderate Potential for Gold and Copper along the Robertson Lake Mylonite Zone 16
Low to Moderate Potential for Massive Sulphide Mineralization 16
Areas of Abundant Veining 17

Conclusions 18

References 19

Appendix 1: Chemical Analyses 21

Metric Conversion Table 26

FIGURES

1. Domain subdivision of the Central Metasedimentary Belt and location of the Puzzle Lake area 1
2. Simplified geology map of the Puzzle Lake area 2
3. Mineral occurrences, soil geochemical anomalies, and interpreted mineral potential of the Puzzle Lake area. 3
4. Jensen plot for metavolcanic rocks from the Puzzle Lake area 5
5. a) Chondrite-normalized REE plot for metavolcanic rocks from the Puzzle Lake area. b) Chondrite-normalized REE plot for metasedimentary rocks from the Puzzle Lake area 6
6. Rb versus Y + Nb discrimination diagram for granitic rocks from the Puzzle Lake area 7
7. Chondrite-normalized REE plot for granite rocks from the Puzzle Lake area 8
8. AFM plot for plutonic rocks from the marble-syenite package, the greenstone-granite package and the Hinchinbrooke and Chippewa plutons. 9
9. Alkali-silica plot for plutonic rocks from the marble-syenite package, the greenstone-granite package and the Hinchinbrooke and Chippewa plutons 9
10. Chondrite-normalized REE plot for syenitic and ultramafic rocks from the Puzzle Lake area 10

11. Plot of K_2O/Na_2O versus SiO_2 illustrating chemical composition of plutonic rocks from the Puzzle Lake area and the average chemical composition of plutons associated with skarn mineralization in the Canadian Cordillera 14

PHOTOS

1. Dark grey weathering carbonate ultramylonite from the western splay of the Robertson Lake mylonite zone 12
2. Massive sulphide clast in carbonate matrix from the Chisholm mine 13
3. Pyrite-epidote-tourmaline-quartz vein cutting amphibolite within the greenstone-granite package due east of the Robertson Lake mylonite zone 17
4. Quartz-tourmaline clots within a monzogranite present along the Tamworth-Parham road 18

TABLES

1. Assay results for samples from the Puzzle Lake area 15

Abstract

Reconnaissance 1:50 000 scale geological mapping was conducted in the Puzzle Lake area (NTS 31C10/SW), a poorly known part of the Central Metasedimentary Belt of the Grenville Province, in 1998. The area is divided in two by the Robertson Lake mylonite zone, which separates upper amphibolite facies gneisses and metaplutonic rocks of the Mazinaw domain in the western third of the map area from middle to upper amphibolite facies supracrustal and metaplutonic rocks of Sharbot Lake domain that underlie the eastern part of the area.

The parts of the area underlain by supracrustal rocks have the highest mineral potential. These include 1) an area immediately west of the Robertson Lake mylonite zone that is underlain by a belt of marble, amphibolite and quartzofeldspathic gneisses that contains anomalous Cu, Zn and Pb values in soils; 2) the Robertson Lake mylonite zone itself, which is a zone of shearing and alteration, and that, further to the north, hosts Au-Cu-Sb mineralization; 3) a belt of mafic and felsic metavolcanic rocks immediately east of the Robertson Lake mylonite zone, that contains FII-type felsic metavolcanic rocks that may host volcanogenic massive sulphide base metal mineralization; and 4) an area within Sharbot Lake domain extending southeast from Fifth Depot Lake toward Tamworth that contains a sequence of marbles extensively intruded by monzonite-syenite-granite plutons and which contains previously exploited zinc occurrences, anomalous Zn values in soils, and a variety of Mo occurrences. This area can reasonably be expected to host wollastonite deposits as well.

Geology and Mineral Potential of the Puzzle Lake Area, Central Metasedimentary Belt, Grenville Province

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Introduction

Approximately 3.5 weeks were spent during 1998 in 1:50 000 scale geological mapping in the Puzzle-Fifth Depot Lake area (NTS 31C/10SW) (Figure 1) in order to better evaluate the mineral potential of this poorly known area. The mineral potential of this area was not easily predictable using pre-existing data, in part because the area lies near the confluence of 3 geological subdivisions (domains and terranes) of the Central Metasedimentary Belt (Figure 1); namely, the Frontenac terrane and the Mazinaw and Sharbot Lake domains, each possessing different mineral commodities and potential. In fact, existing mapping was insufficient to properly assign rocks of the Puzzle Lake area to the various established domains and terranes during the preparation of the Geology of Ontario volume (Easton 1992).

In addition to evaluating the mineral potential and geologic domain structure of the Puzzle Lake area, additional questions to be addressed by this study included determining

1) the location of the Robertson Lake mylonite zone (RLMZ), including any splays

2) the extent and character of the Sharbot Lake domain in the area, and

3) characterization of granitoid rocks in the area with respect to established plutonic suites (e.g., Easton 1992) present in the Central Metasedimentary Belt.

Most of the mapping during this study was concentrated in the western half of the area shown in Figure 2.

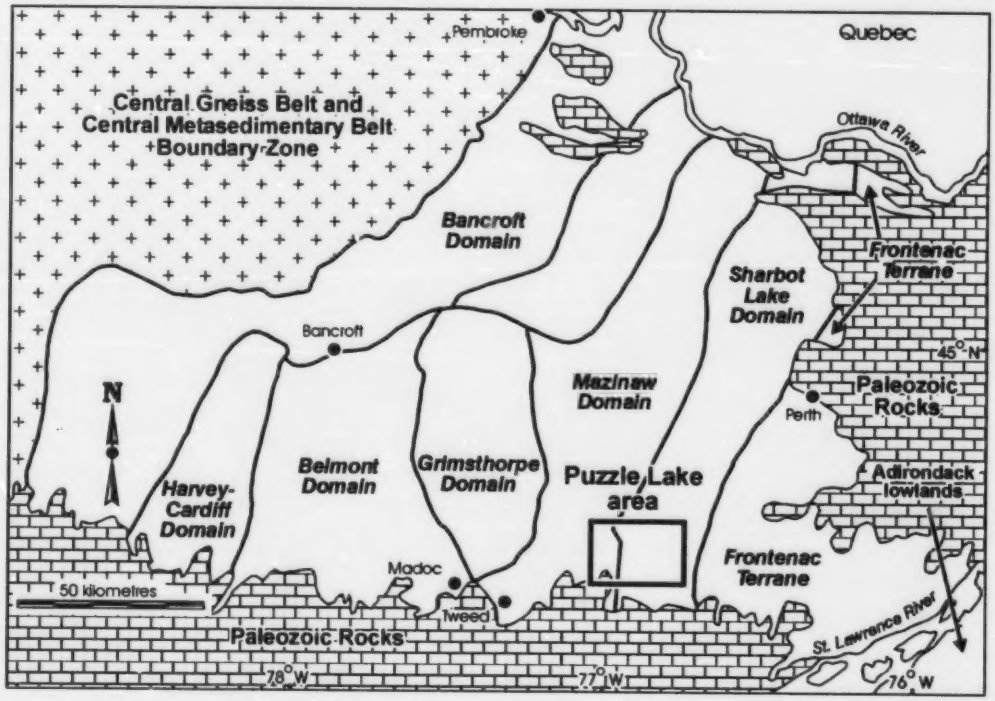

Figure 1. Domain subdivision of the Central Metasedimentary Belt (*after* Easton 1992) showing the location of the Puzzle Lake area.

PREVIOUS WORK

The only previous description of the geology of Sheffield and Camden townships within the Puzzle Lake area is that on the 1:126 720 scale regional compilation map of Hewitt (1964). Hinchinbrooke Township was mapped at 1:63 360 scale by Harding (1951). In addition, Wallach (1973) studied the Hinchinbrooke pluton as part of a thesis study. Detailed mapping (1:31 680 scale) of the area immediately to the north and west of the Puzzle Lake area was conducted by Wolff (1982) and Bright (1986), respectively. Davidson and Ketchum (1993) did some limited reconnaissance work in the southeastern part of the map area. A 1:50 000 scale compilation map of the Tichborne area (NTS 31C/10), incorporating the results of this mapping study and the previous studies noted above, has been published separately (Easton 2001).

Known mineral occurrences within the area are shown in Figure 3, with molybdenum and zinc being the most common commodities reported. During the first 2 decades of the 20th century, several molybdenite occurrences were discovered and exploited, the most significant of these in terms of production being the Chisholm mine (Figure 3). Malczak et al. (1985) summarize most of the base metal and molybdenite occurrences within the map area, although not all previous workings have been reported, as noted by Brack (1993), who discovered additional molybdenite workings north of Cranberry Lake.

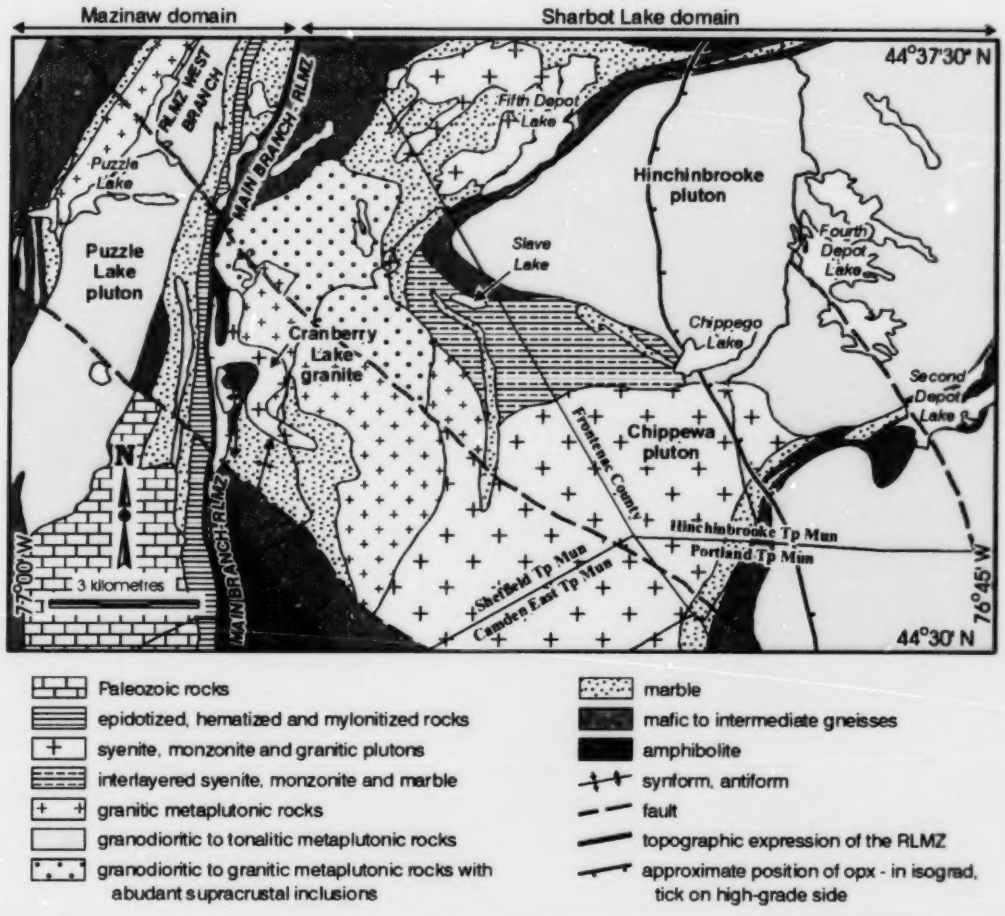

Figure 2. Simplified geology map of the Puzzle Lake area. This study focussed on the western half of the area.

Zinc exploration in the area has focussed on the past-producing Slave Lake mine (see summary in Malczak et al. 1985; also see Kingston 1967; Holmstead et al. 1992; Brack 1993) and on an area south of Norway Lake (St. Joe Canada 1985; Brack 1993)(Figure 3).

Geology

OVERVIEW

The area is underlain by rocks of 2 geological domains of the Central Metasedimentary Belt, the Mazinaw domain underlying the westernmost part of the area, with the Sharbot Lake domain underlying the remainder, as shown in Figures 1 and 2. The boundary between the 2 domains is defined by the main branch of the Robertson Lake mylonite zone (Figure 2). Rocks between the two branches of the Robertson Lake mylonite zone shown in Figure 2 are assigned to the Mazinaw domain, however, as no rock types characteristic of either domain occur in this area, these rocks could also be assigned to Sharbot Lake domain. Metamorphic grade ranges from upper amphibolite within Mazinaw domain rocks west of the main branch of the Robertson Lake mylonite zone, through lower to middle amphibolite facies along the main branch and immediately east of the of the Robertson Lake mylonite zone, rising to granulite facies in the eastern third of the map area. The granulite facies isograd shown in Figure 2 is located mainly through observations along roads, supplemented by mineralogical observations from Wallach (1973) and, consequently, its position is only an approximation.

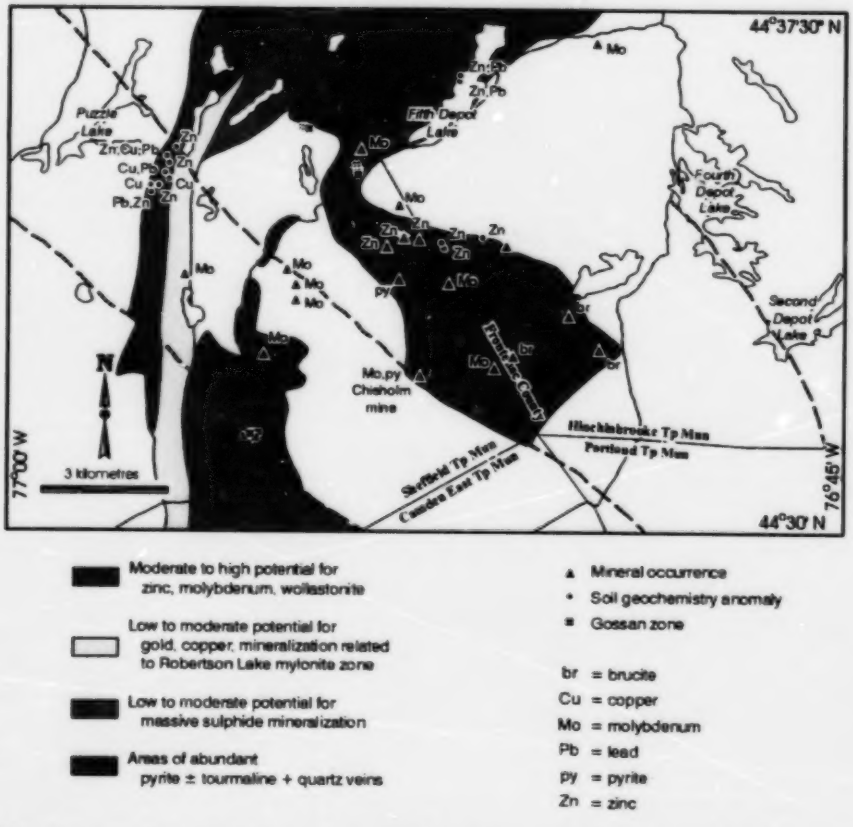

Figure 3. Mineral occurrences, soil geochemical anomalies, and interpreted mineral potential of the Puzzle Lake area.

Some workers have assigned the Hinchinbrooke pluton to Frontenac terrane, based on the presence of granulite facies mineralogy in much of this body, however, no significant break was observed between rocks in the eastern half of the map area and the Hinchinbrooke pluton. In addition, rocks of the Hinchinbrooke pluton are similar in age, lithology, and chemistry to the Elzevir suite (Easton 1992; Wallach 1973) of Mazinaw and Sharbot Lake domains, consequently, the Hinchinbrooke pluton is assigned herein to Sharbot Lake domain. This assignment is supported by the discovery of U-Pb zircon ages characteristic of the Elzevir suite in northern Sharbot Lake domain by Praamsma et al. (2000). It is speculated that the granulite facies conditions observed in the eastern part of the Puzzle Lake area represents a situation similar to that observed in the Wolf Grove area in northeastern Sharbot Lake domain. There, Frontenac terrane metamorphism of ~1168 million years in age overprints rocks of the Sharbot Lake domain (cf. Buckley et al. 1997), with higher metamorphic pressures reported on the Sharbot Lake domain side of the boundary. If so, then by analogy with the Wolf Grove area, metamorphic pressures may be higher within the Hinchinbrooke area than in the adjoining Frontenac terrane proper to the east.

MAZINAW DOMAIN

Rocks within this domain consist of bands of compositionally heterogeneous, thinly layered, mafic to felsic gneisses, likely representing metamorphosed metavolcanic and metasedimentary rocks. These gneisses are probably equivalent to the supracrustal rocks preserved at lower grade within the Clare River synform in the Mellon Lake area to the west based on similarity in rock composition, general stratigraphy and geochemistry, as noted by Bright (1986). Quartzose gneisses within this sequence may represent siliciclastic metasedimentary rocks of either the Grenville Supergroup or the Flinton Group. Calc-silicate and marble units are uncommon west of Puzzle Lake. Locally, these mafic to felsic paragneisses are "juicy" migmatites, containing >20% leucosome. In the case of many of the intermediate to felsic composition gneisses, the presence of a significant orthogneiss component cannot be excluded. The heterogeneous layered gneisses envelop two bodies of migmatitic orthogneiss, namely a granitic body west of Puzzle Lake, and the granodioritic to tonalitic Puzzle Lake pluton (Figure 2). The relationship between the granitic and granodioritic gneisses at Puzzle Lake is similar to that preserved at lower metamorphic grade between the Mitten granite dike (Bright 1986) and the Mellon Lake granodiorite-tonalite-migmatite complex in the adjacent Mellon Lake area. In both the Mellon Lake and Puzzle Lake areas, thin (100 to 200 m) zones of amphibolite are present typically between the plutonic bodies and the surrounding paragneisses. Complex folding patterns were observed in these gneisses south of Gull Lake, however, insufficient traverses were completed to fully unravel the structural style present in this domain.

Between the Puzzle Lake pluton and the Robertson Lake mylonite zone, is an east-dipping zone of amphibolite, marble, and siliciclastic metasediments, which become more strongly mylonitized and altered toward the east, approaching the Robertson Lake mylonite zone. These rocks may be preserved at slightly lower metamorphic grade than rocks west of Puzzle Lake, based mainly on the reduced presence of leucosome within the mafic and felsic gneisses present within this area.

SHARBOT LAKE DOMAIN

Three main rock packages are present within the Sharbot Lake domain in the map area, namely
1) a greenstone-granodiorite package, present mainly adjacent the Robertson Lake mylonite zone,
2) a marble-syenite package, present in the Fifth Depot Lake to Chippego Lake area, and
3) the Hinchinbrooke pluton.

Greenstone-Granodiorite Package

The greenstone-granodiorite package is best exposed in the south-central part of the area along the Tamworth-Parham road (Figure 2). It consists of approximately 750 to 1000 m of amphibolite and metagabbro, overlain by 350 to 500 m of mafic, intermediate and felsic metavolcanics, including felsic pyroclastics, overlain by 150 to 200 m of metawacke and rusty schist, in turn overlain by an unknown thickness of dolomitic and calcitic marbles. Although these rocks are strongly foliated and primary textures are only poorly preserved, the sequence is similar to that observed in the Darling area of Sharbot Lake domain (Easton 1988a). Structural trends are dominantly northwesterly and northeast dipping, and several large scale folds are present (Figure 2).

The geochemistry of the supracrustal rocks is listed in Appendix 1 and summarized in Figures 4 and 5. The metavolcanic rocks are bimodal, and mainly tholeiitic in character, as indicated on AFM, Jensen (Figure 4), and Pearce and Cann trace element discrimination plots. Rare-earth element plots (Figure 5a) show patterns ranging from slightly light rare earth depleted patterns from a gabbro sill (98RME-0132) to relatively flat patterns with rare earth abundances of about 10 times chondrite. These are similar to patterns seen in mafic metavolcanic rocks present in northern Sharbot Lake domain (e.g., Corfu and Easton 1997).

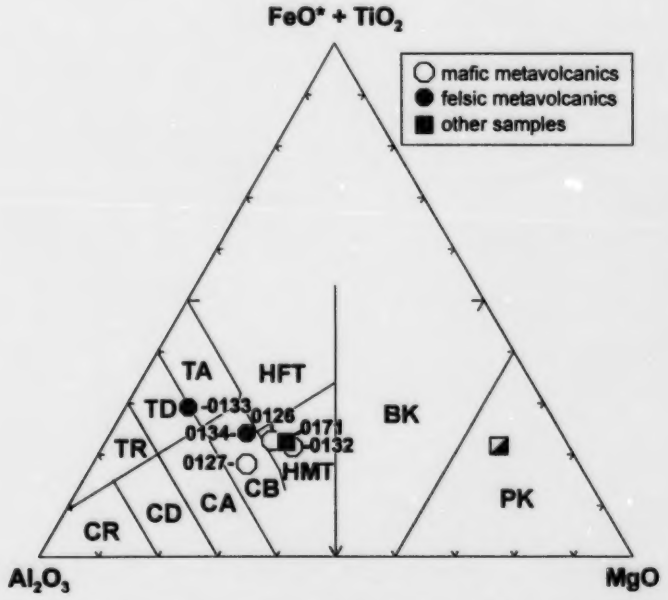

Figure 4. Jensen plot for metavolcanic rocks from the Puzzle Lake area.

Felsic metavolcanic rocks are relatively rare in Sharbot Lake domain, but are relatively abundant in the Puzzle Lake area. Two samples were analyzed, one a felsic monolithic fragmental rock (98RME-0134, Appendix 1, Figure 5a) and the other a more homogeneous rhyodactite (98RME-0133, Appendix 1, Figure 5a). The fragmental rock shows major and trace element chemistry similar to that of the mafic metavolcanic rocks, suggesting that it may contain a high component of mafic material in the matrix or as fragments. The other sample has a Zr/Y ratio of 3.7, Zr 152 ppm, Y 40 ppm, TiO_2 0.79 wt. %, Sc 20 ppm, Sr 136 ppm, and an elevated, flat REE patterns with a negative Eu anomaly. These characteristics are typical of FIIIa type rhyolites, which are typically associated with Archean volcanogenic-massive sulphide (VMS) deposits (e.g., Lesher et al. 1986; Parker and Ayer 1997). This chemical signature is consistent with the interpretation of Corfu and Easton (1997) that Sharbot Lake domain developed on either thickened arc-crust or as a rifted-arc sequence.

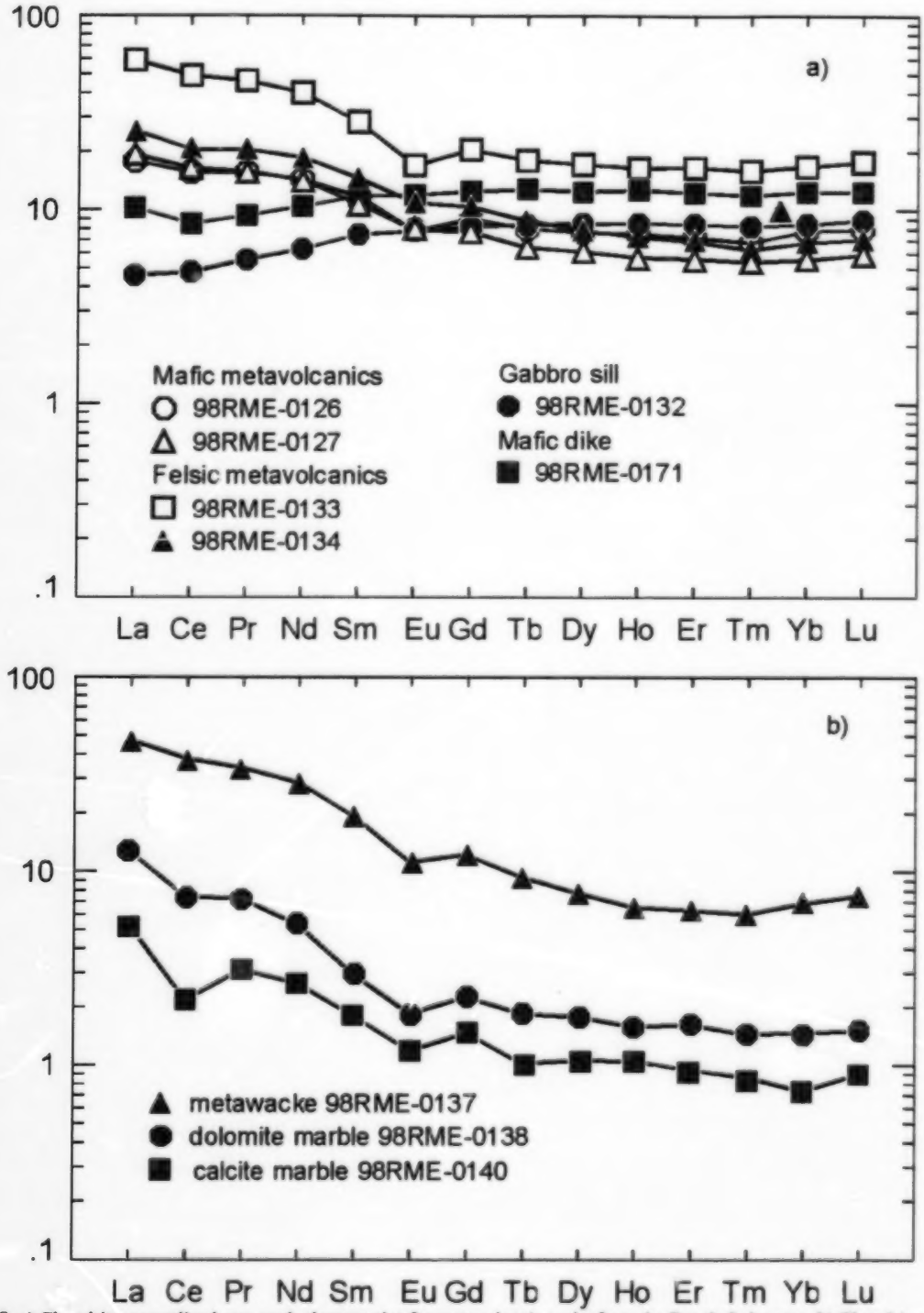

Figure 5. a) Chondrite-normalized rare earth element plot for metavolcanic rocks from the Puzzle Lake area. **b)** Chondrite-normalized rare earth element plot for metasedimentary rocks from the Puzzle Lake area. Normalizing values of Sun and McDonough (1989) are used.

Three metasedimentary rocks were analysed (98RME-0137, -0138, -0140, Appendix 1, Figure 5b). Sample 98RME-0137, a metawacke, exhibits a pattern characteristic of many post-Archean sedimentary rocks, indicating derivation from a source region incorporating continental-like crust (cf. Taylor and McLennan 1985). Both carbonate rocks, a calcite and a dolomite marble (samples 98RME-0140 and 98RME-0138, respectively) show negative Ce anomalies and low total REE abundances. These features are typical of Sharbot Lake domain marbles (Easton 1995). The low total REE abundances indicate little input from either volcanic or sedimentary sources during carbonate deposition.

The supracrustal rocks of the greenstone-granodiorite package are intruded by both medium-grained granodioritic and monzogranitic rocks. In fact, much of the central part of the map area consists of a complex zone of supracrustal remnants and plutonic rocks. Samples of the granitic rocks (Appendix 1) show a volcanic-arc granite affinity on trace element discrimination plots (Figure 6), low to moderate Zr/Y ratios (5.6 to 6.7) and rare-earth element patterns consisting of elevated heavy rare earth elements and pronounced negative Eu anomalies. All are features typical of the Methuen (alaskite) granite suite of ~1240 to 1250 Ma age (cf. Lumbers et al. 1990) common in the Central Metasedimentary Belt.

Near Cranberry Lake, the supracrustal sequence is cut by a coarse-grained syenogranite, the Cranberry Lake pluton, which has an unusual map pattern (Figure 2) in that it seems to both crosscut regional folds in the supracrustal rocks, yet also appears to be folded. It is correlated with the 1090 to 1070 Ma Skootamatta-Kensington suite, as discussed, along with its tectonic significance, in the section on the Robertson Lake mylonite zone. Chemically, the Cranberry Lake granite (Sample 98RME-0268, Figure 6 and 7) is broadly similar to the alaskite suite samples, but has lower SiO_2 and higher Fe_2O_3, Nb, a higher Zr/Y ratio (14.7) and a flatter REE pattern with no Eu anomaly.

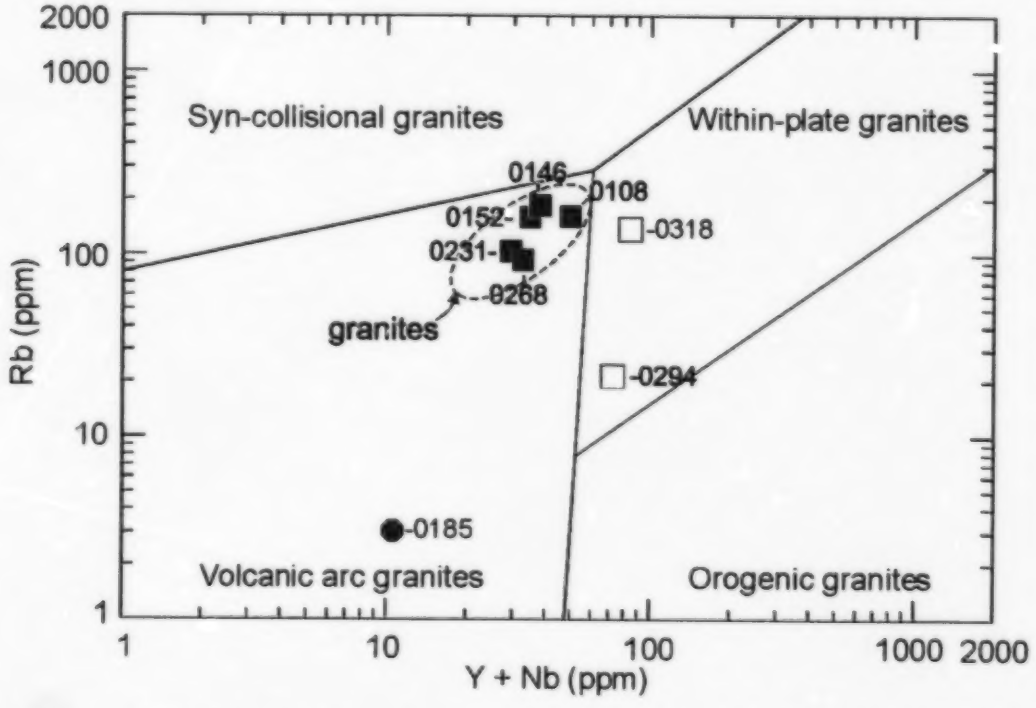

Figure 6. Rb versus Y + Nb discrimination diagram for granitic rocks from the Puzzle Lake area. Alaskite suite granites and the Cranberry Lake granite fall in the volcanic arc granite field. On the complimentary Nb versus Y plot (not shown), all granite samples lie in the volcanic arc granite–syn-collisional granite field.

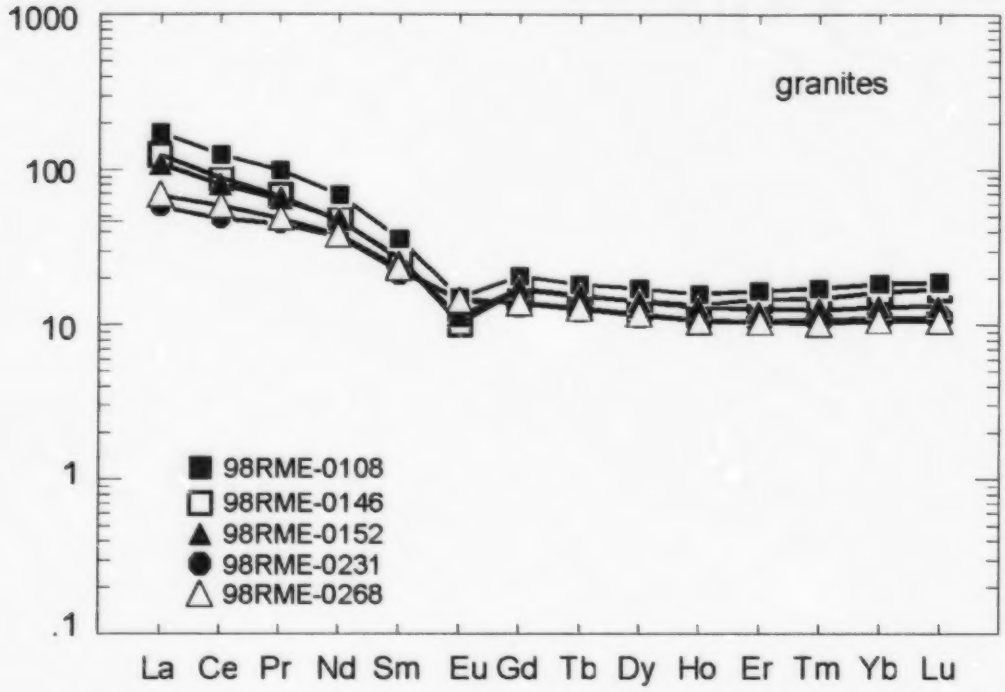

Figure 7. Chondrite-normalized rare earth element plot for granite rocks from the Puzzle Lake area. Normalizing values of Sun and McDonough (1989) are used.

Marble-Syenite Package

The marble-syenite package is present in the Fifth Depot–Slave Lake–Chippego Lake area. It consists of coarse-grained to very coarse-grained calcitic and dolomitic marbles intruded by a variety of syenite, monzonite and granitic plutonic rocks, which texturally, compositionally, and geochemically (Wallach 1973) resemble members of the lithologically and chemically similar 1180 to 1155 Ma Gananoque and 1090 to 1070 Ma Skootamatta-Kensington suites. Without further work, it is not possible to clearly assign these plutonic rocks to either suite. Amphibolite and siliciclastic units are locally present within the marble sequence. In the north, marble and granitoid rocks are separable at 1:50 000 scale, however, southeast of Slave Lake, the plutonic and marble units are intimately mixed, making separation of the 2 rock types difficult except at extremely detailed map scales (interlayered syenite, monzonite and marble unit, Figure 2). The Enterprise complex of Wallach (1973), renamed the Chippewa pluton by Davidson and Ketchum (1993), is part of this rock package. Chemical analyses of the Enterprise complex from Wallach (1973) indicate the presence of at least 2 discrete compositional phases, a monzodiorite to monzonite phase and a syenogranite phase (Appendix 1 and Figures 8, 9). Samples collected by field personnel (Appendix 1 and Figure 10) show a similar distinction between monzodiorite and syenite to syenogranite. Insufficient traverses were conducted to separate individual plutons within this package, or to precisely define the contact between these plutonic rocks and the older granitic-granodioritic rocks present to the west. The relationship between marbles in this package and those associated with the greenstone-granodiorite package is unclear. Marbles in the marble-syenite package could simply be stratigraphically higher equivalents, or alternatively, they could represent a separate carbonate sequence, either in unconformable or tectonic contact with the greenstone-granodiorite package. Regardless, they appear to have been an effective trap in localizing emplacement of the younger plutonic rocks.

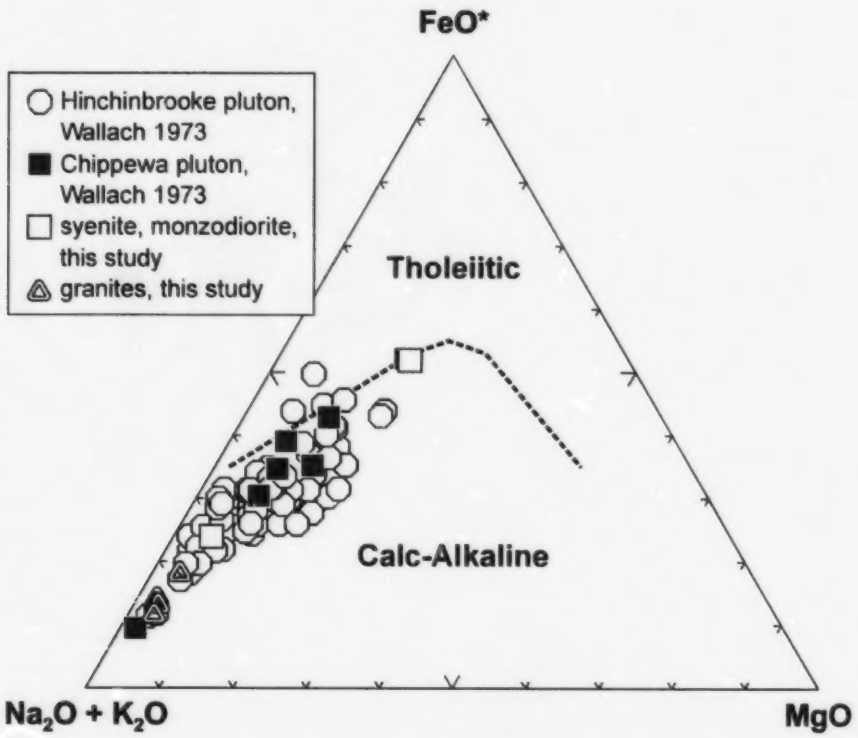

Figure 8. AFM plot for plutonic rocks from the marble-syenite package, the greenstone-granite package and the Hinchinbrooke and Chippewa plutons.

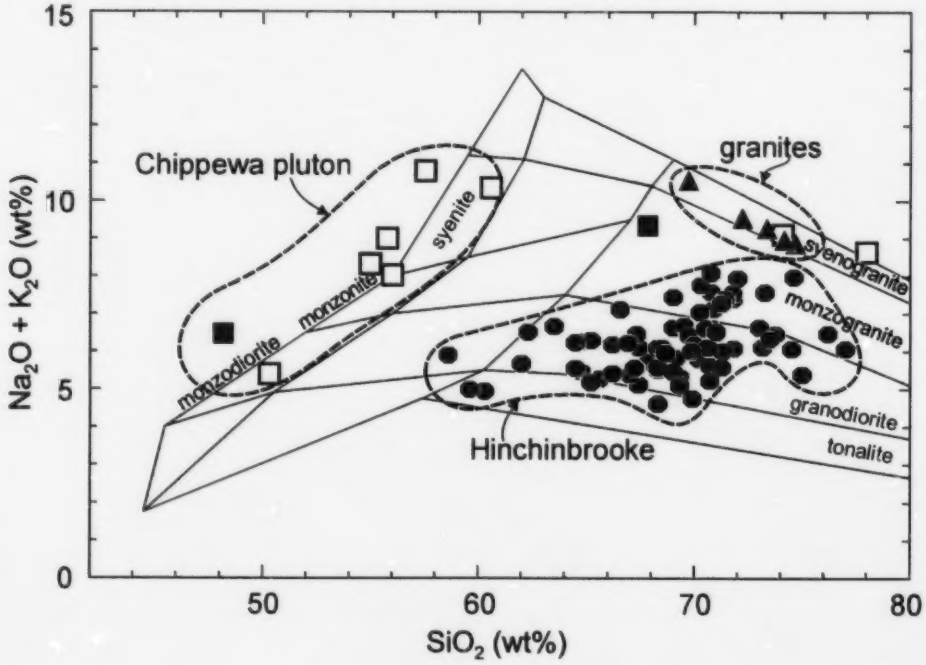

Figure 9. Alkali-silica plot for plutonic rocks from the marble-syenite package, the greenstone-granite package and the Hinchinbrooke and Chippewa plutons. Symbols the same as those used in Figure 8.

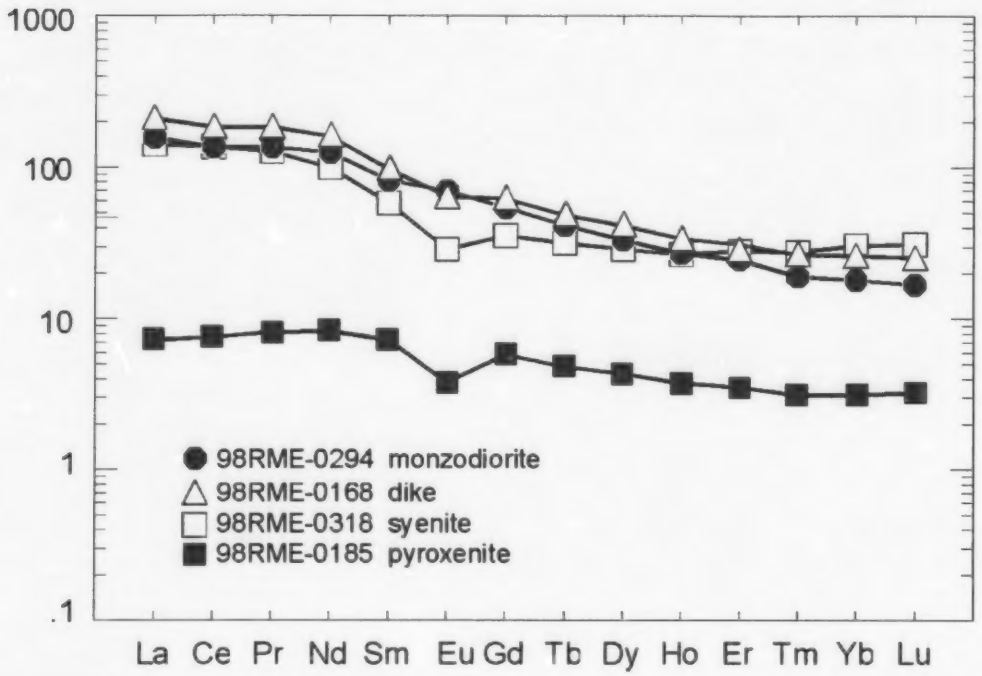

Figure 10. Chondrite-normalized rare earth element plot for syenitic and ultramafic rocks from the Puzzle Lake area. Normalizing values of Sun and McDonough (1989) are used.

Hinchinbrooke Pluton

The Hinchinbrooke pluton is a tonalite-granodiorite body that has been subjected to granulite-facies metamorphism. In the Fifth Depot Lake area, a 200 to 400 m wide sliver of thinly layered, mafic and intermediate composition gneisses separate the body from the marble-syenite sequence. This gneissic rim, including amphibolites, resembles the aforementioned marginal phases observed further west surrounding granodioritic-tonalitic plutons within Mazinaw domain.

These gneisses are cut by metamorphosed, northeast-trending mafic dikes, that have sharp contacts and preserved chill margins. These dikes were not observed within the marble-syenite or the greenstone-granodiorite sequence. Bright (1986) reported mafic dikes cutting the Mellon Lake complex, and it is possible these dikes are of the same suite. Chemical analyses of two of these dikes are given in Appendix 1 (analyses 98RME-0168 and 98RME-0171). The two dikes are chemically distinct, one being tholeiitic in character (98RME-0171, Figure 5a), the other calc-alkalic, and perhaps related to the monzodioritic rocks present in the Chippewa pluton (Figure 10).

At Second Depot Lake, a small ultramafic body is present within gneisses at the contact between the Hinchinbrooke pluton and a marble-amphibolite sequence. The ultramafic rocks are relatively fresh. A chemical sample is presented in Appendix 1 (sample 98RME-0185), and is included in the plots present in Figures 4, 6, and 10. The age and affinity of this body is unknown, however, it could be a mafic member of the Gananoque suite.

Figures 8 and 9 illustrate the major element geochemistry of the Hinchinbrooke pluton, based on analyses reported by Wallach (1973). No samples of the Hinchinbrooke pluton were collected for geochemistry in this study.

Robertson Lake Mylonite Zone

Wolff (1982) mapped the Robertson Lake mylonite zone from Mountain Grove southeastward to just north of Puzzle Lake (west branch of Robertson Lake mylonite zone; Figure 2). In contrast to Wolff's (1982) position, Davidson and Ketchum (1993) show the Robertson Lake mylonite zone paralleling Shibagau Creek, roughly concurrent with the position of the main branch of the Robertson Lake mylonite zone shown in Figure 2. The presence of several prominent linear features in the Mellon Lake–Puzzle Lake area, led Easton (1988b) to suggest that the Robertson Lake mylonite zone might be present as several splays, rather than a single structure.

Determination of the location of the Robertson Lake mylonite zone in the area utilizes the key features of the Robertson Lake mylonite zone observed further north, namely
1) it is a topographically significant feature, serving to localize glacial deposits and subsequent drainage patterns,
2) it separates higher metamorphic grade rocks to the west from lower grade rocks to the east,
3) it is a shallow-dipping structure,
4) rocks along the zone are extensively mylonitized or cataclastic for widths of several hundred metres,
5) abundant development of hematite and epidote (or chlorite at lower grade), and
6) adjacent structural trends are transposed into parallelism with the Robertson Lake mylonite zone trend.

All of these features are associated with the main branch of the Robertson Lake mylonite zone shown in Figure 2. The line shown on the map traces the 30 to 60 m high escarpment that follows the trace of the Robertson Lake mylonite zone in the area. Mylonitic rocks are present at the base of this scarp, dipping shallowly (15 to 20°) to the east. Rocks at the top of the scarp are strongly hematized, epidotized and cut by quartz veins. Quartz stockworks are locally present. In addition, dominantly northwestward structural trends within the greenstone-granodiorite package in the southern part of the map area are transposed into north-trending parallelism with the Robertson Lake mylonite zone (Figure 2). Metamorphic grade of the Robertson Lake mylonite zone appears to be lower amphibolite facies, in contrast to the middle greenschist facies along the Robertson Lake mylonite zone in the Darling area (Easton 1988a).

A splay of the Robertson Lake mylonite zone does strike from the Long Lake area through Puzzle Lake (Figure 2). However, apart from the development of a narrow (100 m?) fine-grained, black to grey, marble mylonite breccia zone exposed on a few islands and peninsulas on the north end of Puzzle Lake, the Robertson Lake mylonite zone has little effect on the adjacent orthogneisses present on either shore of Puzzle Lake. Similar breccia is preserved on strike in the Long Lake area to the northeast, within the area mapped by Wolff (1982) as part of the Robertson Lake mylonite zone (Photo 1). South of Puzzle Lake, this splay of the Robertson Lake mylonite zone is not easily traced. Poorly exposed gritty carbonates south of Little Gull Lake may represent the southward continuation of this splay.

The Cranberry Lake pluton is altered by the Robertson Lake mylonite zone, however, plutonic rocks of this pluton are not strongly mylonitized, and locally appear to inject more strongly mylonitized rocks. In addition, as shown in Figure 2, the western edge of the pluton appears to be injected parallel to, or transposed into parallelism with the Robertson Lake mylonite zone. Wolff (1982) observed similar relationships between the 1073 Ma (Davidson and Easton 1994) McLean pluton and the Robertson Lake mylonite zone. If this is the case, it suggests that the Robertson Lake mylonite zone may have been active prior to 1073 Ma, even though further north it juxtaposes rocks metamorphosed as young as 1020 Ma against cooler rocks. For this reason, it is suggested that the Cranberry Lake pluton is part of the Skootamatta-Kensington suite, rather than the Gananoque suite.

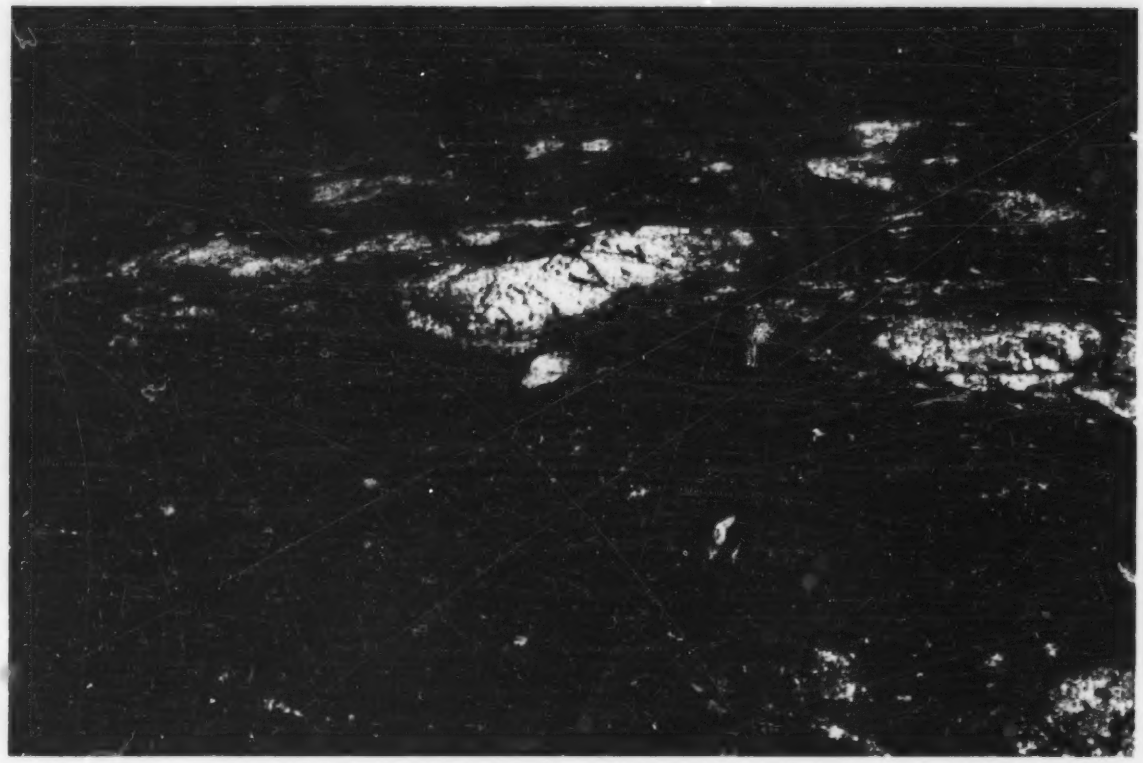

Photo 1. Dark grey weathering carbonate ultramylonite containing rounded clasts and fragments of bleached granitoid material from the western splay of the Robertson Lake mylonite zone. Samples 98RME-0337 and 98RME-0338, Table 1, are from this outcrop. UTM zone 18T, 346177E, 4945514N.

Economic Geology

OVERVIEW

Figure 3 shows the location of previously recorded mineral occurrences in the area (Hewitt 1964; Malczak et al. 1985), as well as additional occurrences noted in the assessment files. In addition, soil geochemical anomalies reported in the assessment files are also shown. Figure 3 also provides a provisional interpretation of the mineral potential of the area, based on field observations and the distribution of occurrences. Areas of lower mineral potential in the area include the high-grade rocks of Mazinaw domain, and the area underlain by the Hinchinbrooke pluton. Note that the area north of Norway Lake is difficult to access, consequently, the geology of this area could not be adequately evaluated, even though it is likely underlain by both carbonate and metavolcanic rocks. Assay results from samples collected by the author are listed in Table 1.

MODERATE TO HIGH POTENTIAL FOR ZINC, MOLYBDENUM AND WOLLASTONITE

This region corresponds to the area underlain by the marble-syenite package and the marble belt west of the main branch of the Robertson Lake mylonite zone. The rating of the potential of this package is based on the following reasons:

1) the presence of known zinc mineralization in a 5 km long belt in the Slave Lake area.

2) the presence of zinc soil anomalies in the Fifth Depot Lake area (Brack 1993).

3) the presence of more marble in the area than shown on previous maps.

4) the occurrence of dolomite marble throughout part of this belt, and in the Fifth Depot Lake area, the occurrence of extremely coarse-grained calcitic marbles, similar to those present at the Long Lake zinc mine (Wolff 1982).

5) Easton (1995), on geochemical grounds, suggested that contact aureoles of plutons of the 1090 to 1070 Ma Skootamatta-Kensington suite were targets for zinc and wollastonite mineralization that formed predominantly in a manto-type setting (e.g., Nelson 1991), although contact skarn deposits might also be present. As noted above, plutons in this belt are either 1180 to 1160 or 1090 to 1070 Ma in age. The abundance of molybdenite showings associated with these plutons also suggests interaction between the plutons and the marbles. In addition, the Chisholm mine is a base metal deposit (pyrite, pyrrhotite) with associated molybdenite (Photo 2), not a molybdenite vein or skarn, consistent with formation as a manto

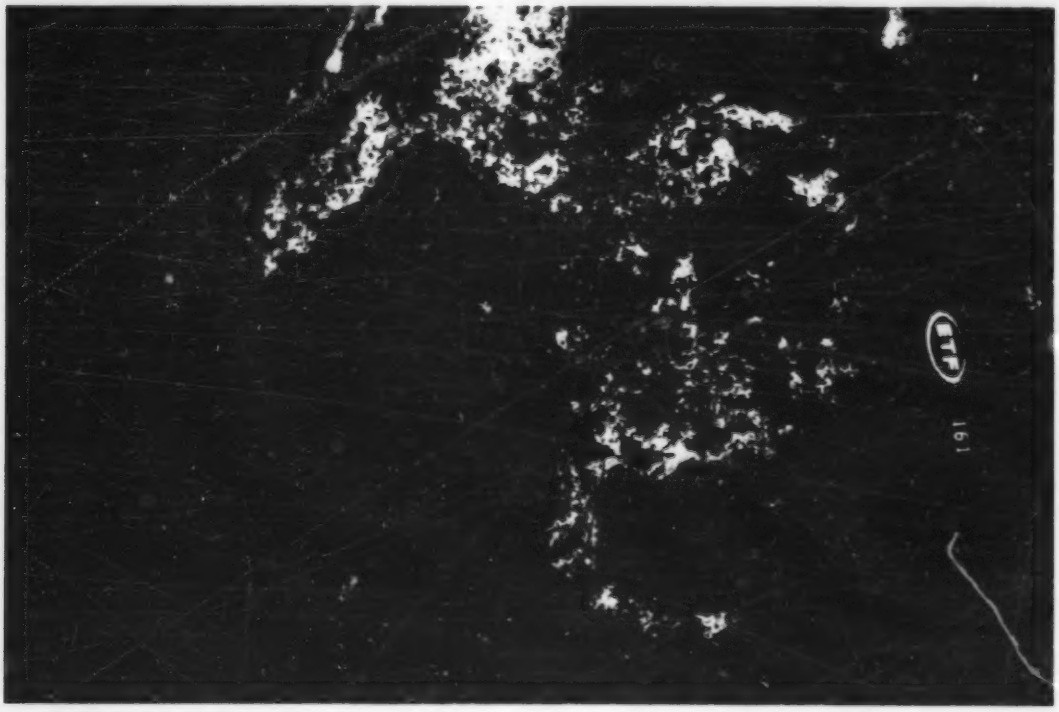

Photo 2. Massive sulphide clast (centre) in carbonate matrix from the Chisholm mine. UTM zone 18T, 350610E, 4933002N.

deposit (cf. Nelson 1991). The Chisholm mine is spatially associated with monzogranite of the Chippewa pluton.

6) Associated mineralization that might be expected along with zinc, includes wollastonite, molybdenite, tin and fluorite. Tin and fluorite are commonly associated with manto deposits (Nelson 1991), and geochemical comparisons with younger skarn systems (cf. Ray and Webster 1991) suggest that the syenogranitic phases of the Chippewa pluton may host Sn in addition to Mo mineralization (Figure 11). According to Wallach's (1973) limited chemical data on this body, the syenogranite phase occurs mainly along the eastern margin of the body, south of Chippego Lake. Based on the available geochemical data and field observations, zinc mineralization appears to be associated with monzodioritic to monzonitic intrusive phases, whereas known molybdenite occurrences are associated with monzo- to syenogranitic phases.

Note that the area south of Norway Lake is only ranked high potential for zinc, based on previous exploration. This area lacks the associated syenite plutons, and their related mineralizing factors.

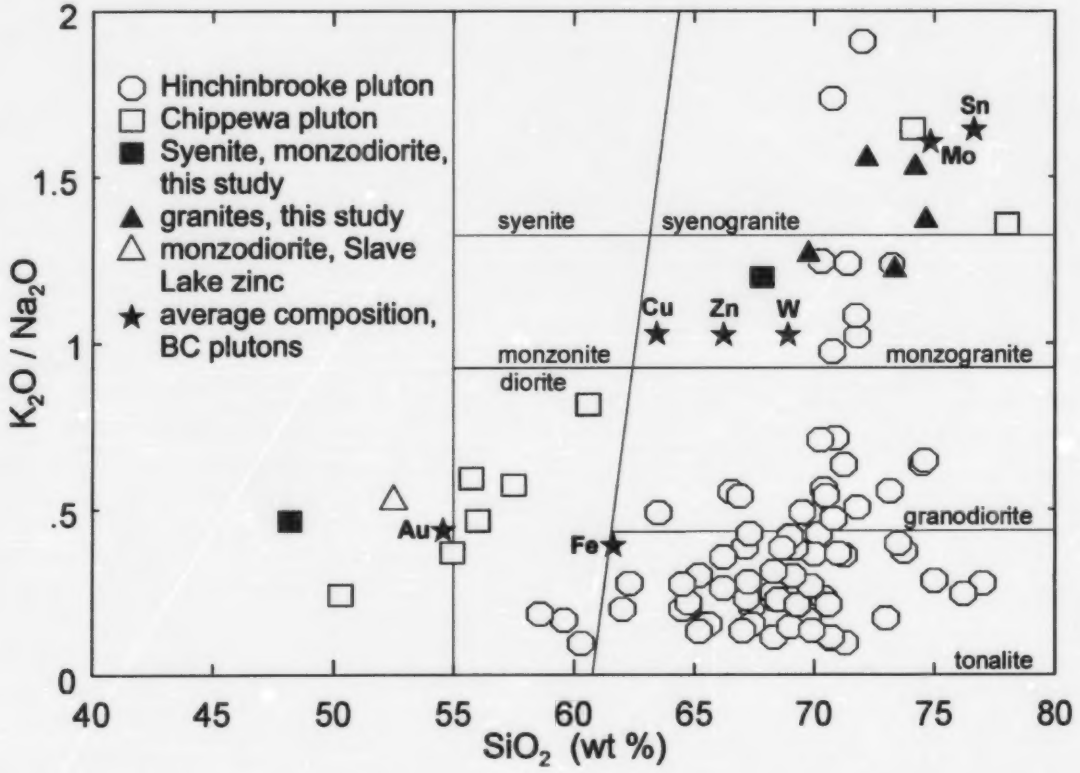

Figure 11. Plot of K_2O/Na_2O versus SiO_2 after Ray and Webster (1991) illustrating chemical composition of plutonic rocks from the Puzzle Lake area and the average chemical composition of plutons associated with skarn mineralization in the Canadian Cordillera. Syenogranites of the Chippewa pluton lie in the compositional field of Mo and Sn skarns. Monzogranites of the Chippewa pluton lie in the compositional field of Zn and W skarns.

Table 1: Assay results for samples from the Puzzle Lake area.

Sample No.	Easting	Northing	Field Rock Name	Au	Pt	Pd	Cu	Mo	Ni	Pb	Zn
	Zone	18T		ppb(2)	ppb(1)	ppb(1)	ppm (5)*	ppm (8)*	ppm (5)*	ppm(3)*	ppm(2)*
98RME-0125	345310	4929825	py-ep-tur-qtz vein cutting amphibolite	4	2	2	968	<8	<5	7	74
98RME-0137	346828	4931639	tur-qtz vein in metawacke	3	1	1	11	10	10	5	74
98RME-0143	346612	4934104	tur-qtz vein in granite	3	2	1	<5	<8	<5	5	12
98RME-0147	346715	4934955	sulphide-rock at edge of tur-qtz vein	<2	<1	<1	30	10	10	6	51
98RME-0148	346715	4934955	tur-qtz vein in marble/granite	3	1	1	<5	<8	<5	6	18
98RME-0150	346750	4935295	py-po clots in granite	3	1	1	<5	11	11	9	8
98RME-0153	347085	4936118	py-qtz vein in granite	81	N.D.	1	14	11	11	7	9
98RME-0154	347085	4936118	altered granite beside py-qtz vein	4	1	1	5	<8	<5	17	43
98RME-0135	346427	4931469	gossan in felsic tuff	4	6	6	39	11	11	75	45
98RME-0136	346757	4931627	gossan in felsic tuff	3	1	2	20	<8	<5	12	106
98RME-0138	347019	4931730	sulphide in dolomite marble	3	3	4	12	<8	<5	34	266
98RME-0139	347115	4931927	sulphide in dolomite marble	2	1	1	251	<8	<5	8	45
98RME-0140	346950	4932648	fetid calcite marble	3	1	1	<5	<8	<5	7	5
98RME-0149	346715	4934955	sulphide in silicified marble	3	1	1	26	280	280	11	30
98RME-0165	348970	4938030	calcite marble	4	4	6	7	<8	<5	18	32
98RME-0167	349335	4938545	gossan zone (weathered)	88	8	11	24	<8	<5	8	173
98RME-0168	349335	4938545	gossan zone (fresh)	18	3	5	156	40	40	N.D.	16
98RME-0207	344910	4938510	rusty schist and marble	20	3	5	60	16	16	N.D.	26
98RME-0208	344815	4938500	marble with diss sulphide, powerline, Norway Lake zinc prospect	39	257	224	<5	<8	<5	4	10
98RME-0236	350610	4933002	Chisholm mine, sulphide ore	23	2	2	234	35	44	N.D.	50
98RME-0237	350610	4933002	Chisholm mine, impure marble	1	1	N.D.	14	N.D.	23	11	55
98RME-0238	350610	4933002	Chisholm mine, scapolite skarn with sulphide	21	40	48	338	N.D.	48	N.D.	60
98RME-0239	350610	4933002	Chisholm mine, scapolite skarn with visible molybdenite	N.D.	N.D.	N.D.	559	3298	39	N.D.	66
98RME-0240	350610	4933002	Chisholm mine, altered syenogranite	N.D.	N.D.	N.D.	9	11	6	N.D.	56
98RME-0242	350187	4936287	Roadside outcrop on east side of township road on Slave Lake zinc property, dolomite marble with hematitic porphyroblasts	6	N.D.	N.D.	467	N.D.	16	10	79046
98RME-0288	346220	4928106	rusty monzogranite	63	204	231	26	N.D.	12	N.D.	244
98RME-0292	344694	4927713	rusty granitoid with disseminated sulphide	N.D.	1	N.D.	24	N.D.	8	N.D.	118
98RME-0321	348050	4939725	rusty schist	5	N.A.	N.A.	28	15	N.D.	5	10
98RME-0323	347968	4939253	rusty schist	4	N.A.	N.A.	131	10	138	9	55

Abbreviations: N.D = not detected, N.A. = not analyzed, ep = epidote, po = pyrrhotite, py = pyrite, qtz = quartz, tur = tourmaline.
* number in brackets indicates detection limit for the respective element

Table 1: continued.

Sample No.	Easting	Northing	Field Rock Name	Au	Pt	Pd	Cu	Mo	Ni	Pb	Zn
	Zone	18T		ppb(2)	ppb(1)	ppb(1)	ppm (5)*	ppm (8)*	ppm (5)*	ppm(3)*	ppm(2)*
98RME-0122	344855	4929790	RLMZ, felsic mylonite	4	3	4	86	<8	<5	5	46
98RME-0123	345220	4929820	RLMZ, gossanous mylonite	9	2	17	87	<8	<5	10	65
98RME-0224	345215	4934040	RLMZ, gossan zone in epidotized granite	1	1	1	6	10	N.D.	5	6
98RME-0225	345190	4934295	RLMZ, calcitic marble	1	N.D.	N.D.	N.D.	N.D.	8	9	8
98RME-0226	345143	4935170	RLMZ, gossan zone in epidotized granite	N.D.	N.D.	N.D.	N.D.	10	8	6	48
98RME-0227	345269	4935478	RLMZ, skarn rock	N.D.	1	1	5	10	14	N.D.	40
98RME-0299	345080	4930995	RLMZ, gossan in epidotized gabbro	N.D.	N.D.	N.D.	32	N.D.	23	N.D.	114
98RME-0300	345129	4931160	RLMZ, gossan in epidotized amphibolite	N.D.	N.D.	N.D.	126	N.D.	16	N.D.	104
98RME-0301	345047	4931584	RLMZ, quartz vein cutting amphibolite	N.D.	N.D.	N.D.	6	N.D.	16	N.D.	49
98RME-0337	346177	4945514	RLMZ, trondhjemite in marble mylonite	2	N.A.	N.A.	31	N.D.	N.D.	31	18
98RME-0338	346177	4945514	RLMZ, marble mylonite	4	N.A.	N.A.	17	N.D.	17	7	636

Abreviations: N.D = not detected, N.A. = not analyzed, RLMZ = Robertson Lake mylonite zone.
* number in brackets indicates detection limit for the respective element

LOW TO MODERATE POTENTIAL FOR GOLD AND COPPER ALONG THE ROBERTSON LAKE MYLONITE ZONE

Based on the occurrence of gold and tetrahedrite occurrences along the Robertson Lake mylonite zone to the north, this area might be expected to host similar mineralization. The presence of many gossan zones, quartz veins and quartz stockworks in the mylonitic rocks in the Robertson Lake mylonite zone, and along the escarpment marking this zone is also encouraging. Assay samples from some of these zones, veins and rocks are reported in Table 1. The apparent higher grade of the Robertson Lake mylonite zone in the Puzzle Lake area is responsible for the mineral potential not being ranked higher.

LOW TO MODERATE POTENTIAL FOR MASSIVE SULPHIDE MINERALIZATION

This area outlines the middle amphibolite greenstone-granodiorite package, which includes both mafic and felsic metavolcanics and rusty schists and gossan zones capping the metavolcanic sequence. Potential for volcanogenic-massive sulphide mineralization was rated low in an earlier report (Easton 1999), but given the presence of FIII rhyolites in the package, a rating of moderate may be more appropriate for this package.

AREAS OF ABUNDANT VEINING

Large sections along the Tamworth-Parham road contain pyrite-tourmaline-quartz veins (Photos 3 and 4), which occur in all rock units of the greenstone-granodiorite package. Extensive bleaching of the host rocks to these veins is present (Photo 4). This type of alteration has been observed by the author previously in the Mazinaw Lake area in association with gold occurrences in that region (Easton and Ford 1991). At present, it is unclear if the concentration of these veins along the road simply reflects improved exposure, or whether there is some other factor serving to localize veins in this area. Assays from these veins and the bleached zones are reported in Table 1. One sample (98RME-0153) was anomalous in gold; another (98RME-125, Photo 3) was enriched in copper; none of the others showed any appreciable metal enrichment.

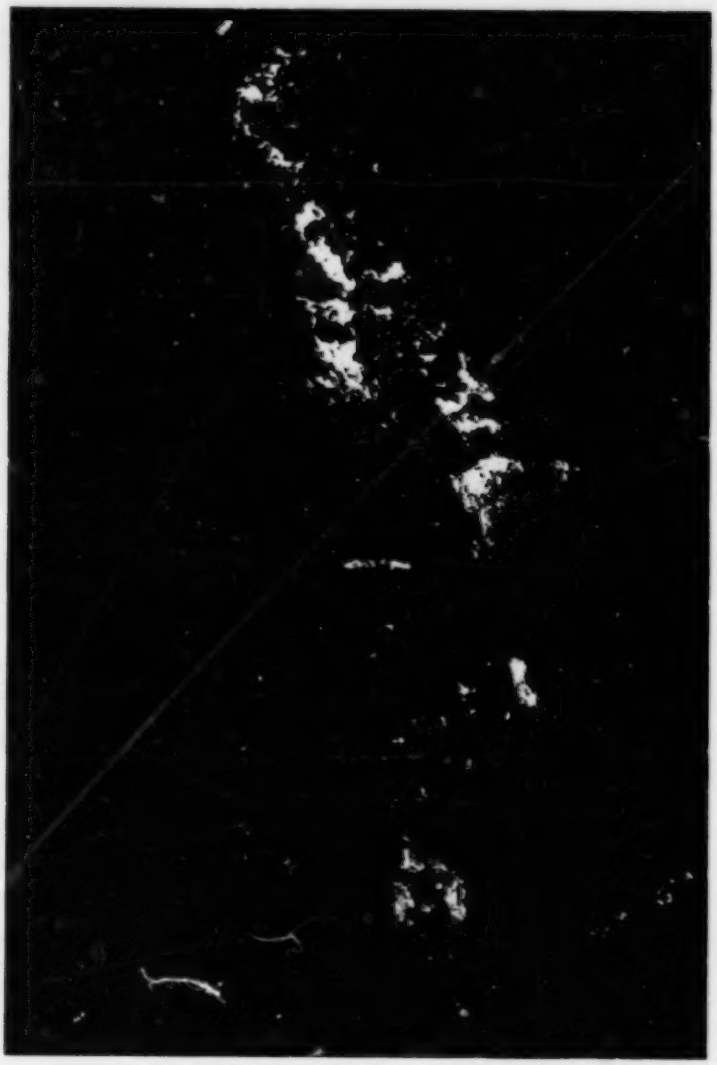

Photo 3. Pyrite-epidote-tourmaline-quartz vein cutting amphibolite within the greenstone-granite package due east of the Robertson Lake mylonite zone. Sample 98RME-0125, Table 1, from this vein contained 968 ppm copper. UTM zone 18T, 345310E, 4929825N.

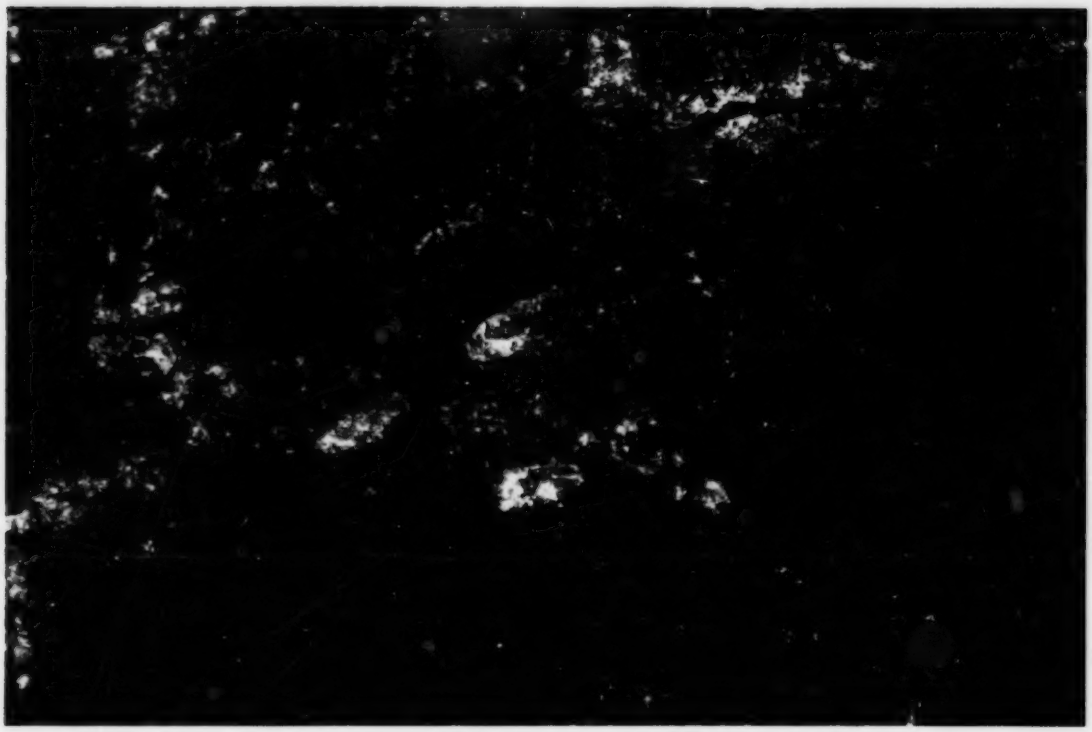

Photo 4. Quartz-tourmaline clots (black areas in photograph) within a monzogranite present along the Tamworth-Parham road. Note areas of bleaching (lighter greys in photograph) adjacent to the clots. Station 98RME-0142, UTM zone 18T, 346626E, 4933930N.

Conclusions

1) The Puzzle Lake area is underlain by rocks of the Mazinaw and Sharbot Lake domains. The Robertson Lake mylonite zone trends northerly through the area, paralleling Shibagau Creek. A splay of the Robertson Lake mylonite zone runs through Puzzle Lake.

2) Metamorphic grade is lowest immediately east of the Robertson Lake mylonite zone.

3) Supracrustal rocks, especially marbles, are more abundant than shown on previous maps.

4) Much of Sharbot Lake domain is underlain by syenite-monzonite-granite plutons of the Gananoque and Skootamatta-Kensington suites.

5) The central part of the area has moderate to high mineral potential for zinc, molybdenum and wollastonite.

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Appendix 1: Chemical Analyses

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a. Analyses of samples collected by Ontario Geological Survey personnel from the Puzzle Lake area and analyzed by the Geoscience Laboratories, Ministry of Northern Development and Mines.

b. Analyses of samples from the Puzzle Lake area from the literature (Wallach 1973).

Appendix 1a. Chemical analyses of rocks from the Puzzle Lake area collected during thus study.

Sample No.	Easting	Northing	Rock Type	SiO2	TiO2	Al2O3	Fe2O3*	MnO	MgO	CaO	Na2O	K2O
98RME-0108	352150	4941360	granite	72.20	0.28	14.10	1.71	0.02	0.37	0.77	3.73	5.83
98RME-0122	344855	4929790	mylonite	61.64	0.37	14.27	6.02	0.09	3.12	5.34	5.87	1.00
98RME-0126	345348	4929850	amphibolite	47.73	0.60	17.38	11.91	0.20	7.73	8.88	3.27	1.44
98RME-0127	345495	4929855	amphibolite	51.09	0.37	18.00	8.75	0.24	6.59	9.71	3.69	0.86
98RME-0132	345875	4930783	gabbro	48.90	0.66	15.40	10.47	0.18	8.38	12.43	2.31	0.48
98RME-0133	345930	4930900	felsic volcanic	63.01	0.79	14.00	9.82	0.14	1.93	3.90	4.76	1.44
98RME-0134	346277	4931313	felsic volcanic	47.81	0.60	16.50	11.17	0.19	5.64	11.50	3.10	1.23
98RME-0137	346828	4931639	metawacke	77.33	0.39	10.22	3.63	0.06	1.28	1.25	3.52	1.29
98RME-0138	347019	4931730	dolomite marble	2.14	0.01	0.28	0.46	0.03	21.04	30.66	0.03	0.06
98RME-0140	346950	4932648	calcite marble	1.92	0.02	0.28	0.22	0.03	3.88	51.86	0.05	0.10
98RME-0146	346635	4934811	granite	73.36	0.20	13.71	1.79	0.04	0.29	1.06	4.15	5.09
98RME-0152	346886	4935745	granite	74.22	0.18	13.42	1.60	0.03	0.29	0.85	3.53	5.43
98RME-0168	349850	4938910	diabase	51.08	3.27	14.29	13.27	0.07	4.26	4.80	3.21	3.26
98RME-0171	350790	4939120	diabase	48.11	0.94	16.97	11.71	0.17	8.70	10.56	2.56	0.58
98RME-0185	360300	4933900	pyroxenite	38.81	0.80	5.98	16.39	0.15	26.73	3.24	0.17	0.03
98RME-0231	345950	4935577	granite	74.66	0.16	13.51	1.39	0.03	0.35	0.71	3.74	5.15
98RME-0268	345278	4936511	granite	69.74	0.37	15.04	2.84	0.02	0.45	0.48	4.63	5.90
98RME-0294	343105	4925034	monzodiorite	48.20	2.62	16.26	12.44	0.19	3.92	7.08	4.41	2.05
98RME-0318	348950	4940625	syenite	67.81	0.59	15.43	3.50	0.06	0.67	1.81	4.24	5.08
80TRC-0036			syenite	52.50	1.68	18.60	9.31	0.15	2.77	5.46	5.37	2.88
80TRC-0037			pelitic rock	50.60	2.46	17.00	10.30	0.16	2.82	5.98	5.00	2.78

Sample No.	P2O5	H2O	CO2	S	LOI	Total	Mg #	Cr	Ni	Co	Sc	V	Cu	Pb
98RME-0108	0.05	0.11	0.18	0.01	0.53	99.59	30.05	11	<5	<5	<1	11	<5	4
98RME-0122	0.11	0.18	1.23	0.24	1.95	99.78	50.65	73	20	17	17	152	74	1
98RME-0126	0.10	0.10	0.09	<0.01	0.95	100.19	56.25	147	56	39	35	78	<5	5
98RME-0127	0.09	0.08	0.06	0.02	0.68	100.07	59.85	89	44	30	29	242	15	63
98RME-0132	0.04	<0.01	0.12	0.04	0.66	99.91	61.31	458	84	43	49	186	103	6
98RME-0133	0.22	0.11	0.10	0.11	0.50	100.51	28.01	15	10	20	20	246	164	7
98RME-0134	0.12	0.13	0.97	0.07	2.75	100.61	50.00	97	52	37	33	139	46	3
98RME-0137	0.18	0.12	0.94	0.32	1.33	100.48	41.10	44	10	6	9	245	33	5
98RME-0138	0.01	0.08	45.10	<0.01	45.77	100.49	98.90	3	16	<5	<1	57	<5	<1
98RME-0140	0.02	0.03	42.50	0.01	42.90	101.28	97.19	3	9	<5	<1	18	<5	<1
98RME-0146	0.04	0.11	0.10	<0.01	0.40	100.13	24.26	9	-5	<5	3	10	<5	13
98RME-0152	0.03	0.08	0.07	<0.01	0.43	100.01	26.43	44	-5	<5	2	11	<5	11
98RME-0168	1.63	0.27	0.44	0.25	0.73	99.87	38.86	24	39	30	16	9	27	6
98RME-0171	0.09	0.14	0.32	0.16	0.98	101.37	59.54	172	132	51	31	192	84	3
98RME-0185	0.12	0.49	0.27	0.04	6.26	98.68	76.36	2067	831	90	12	225	<5	<1
98RME-0231	0.04	0.11	0.08	0.03	0.60	100.34	33.32	20	<5	<5	1	54	<5	4
98RME-0268	0.09	0.10	0.07	0.02	0.50	100.06	23.90	15	6	<5	3	12	<5	2
98RME-0294	1.23	0.16	0.19	0.35	1.21	99.61	38.43	12	17	23	18	16	20	4
98RME-0318	0.16	0.07	0.05	0.02	0.28	99.63	27.51	6	6	<5	3	151	<5	4
80TRC-0036	0.63					99.35	37.08							
80TRC-0037	1.16					98.26	35.16							

Appendix 1a. continued.

Sample No.	Zn	Sn	Mo	As	Rb	Cs	Ba	Sr	Ga	Be	Ta	Nb	Hf	Zr	Y	Th	U
98RME-0108	22	<3	<8	<4	159	0.21	616	140	19	<3	0.65	9.5	4.15	225	40	13.54	1.59
98RME-0122	48	<3	<8	<4	22	0.15	219	156	12	<3	0.18	3.1	2.23	101	24	3.23	1.36
98RME-0126	120	<3	<8	<4	108	9.31	632	147	15	<3	0.08	1.4	0.82	42	22	1.12	0.38
98RME-0127	329	<3	<8	<4	11	0.60	179	288	14	<3	0.06	1.2	0.55	34	13	1.34	0.60
98RME-0132	92	<3	<8	<4	10	0.33	115	157	15	<3	0.04	0.5	0.54	29	17	0.16	0.09
98RME-0133	101	<3	<8	<4	27	1.36	297	136	15	<3	0.26	4.2	3.25	152	40	4.54	1.87
98RME-0134	114	<3	<8	<4	34	0.49	288	260	14	<3	0.07	1.3	0.70	37	14	1.54	0.76
98RME-0137	70	<3	<8	<4	31	0.81	300	140	11	<3	0.41	5.5	3.52	163	32	4.42	1.24
98RME-0138	17	<3	<8	28	2	0.17	17	54	<1	<3	0.02	0.1	0.10	<1	2	0.24	0.12
98RME-0140	8	<3	<8	27	3	0.23	52	481	<1	<3	0.02	0.2	0.08	4	<1	0.06	0.06
98RME-0146	67	<3	<8	<4	183	1.74	638	144	18	<3	0.56	7.8	5.47	188	30	18.01	3.19
98RME-0152	42	<3	<8	<4	158	1.01	753	130	15	<3	0.45	5.9	4.99	193	29	13.37	2.80
98RME-0168	170	<3	<8	<4	55	0.35	1425	556	23	4	1.72	32.1	3.50	548	79	2.58	0.93
98RME-0171	101	<3	<8	<4	11	0.14	190	168	17	<3	0.04	0.8	1.37	42	29	0.14	0.11
98RME-0185	50	<3	<8	12	3	0.33	17	74	6	<3	0.10	1.6	1.05	51	9	0.36	0.15
98RME-0231	22	<3	<8	<4	102	0.40	783	167	16	<3	0.52	5.3	1.41	102	24	3.16	1.20
98RME-0268	25	<3	<8	<4	91	0.27	782	113	19	<3	0.35	7.7	3.46	373	25	3.45	1.37
98RME-0294	138	<3	<8	<4	21	0.82	2022	1299	22	<3	0.63	12.1	1.03	122	60	0.81	0.35
98RME-0318	56	<3	<8	<4	135	0.32	877	264	19	<3	1.12	17.7	3.78	363	66	7.60	3.05

Sample No.	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
98RME-0108	57.42	108.48	13.00	43.75	7.33	1.16	5.72	0.91	5.88	1.22	3.74	0.61	4.05	0.64
98RME-0122	11.28	24.94	3.55	15.04	3.50	0.82	3.28	0.52	3.29	0.72	2.13	0.33	2.21	0.36
98RME-0126	5.88	13.56	2.04	9.05	2.38	0.60	2.48	0.40	2.65	0.58	1.63	0.24	1.72	0.27
98RME-0127	6.35	14.21	2.05	8.98	2.18	0.61	2.13	0.32	2.09	0.44	1.26	0.19	1.22	0.20
98RME-0132	1.51	4.13	0.72	3.96	1.51	0.60	2.26	0.42	2.92	0.66	1.91	0.29	1.87	0.30
98RME-0133	19.39	42.49	5.99	25.24	5.77	1.31	5.67	0.90	5.90	1.27	3.73	0.56	3.69	0.60
98RME-0134	8.42	17.67	2.65	11.73	2.95	0.84	2.88	0.44	2.70	0.56	1.55	0.22	1.50	0.24
98RME-0137	15.44	32.53	4.39	17.95	3.87	0.85	3.33	0.46	2.63	0.50	1.41	0.21	1.49	0.25
98RME-0138	4.12	6.35	0.93	3.32	0.59	0.14	0.61	0.09	0.60	0.12	0.36	0.05	0.32	0.05
98RME-0140	1.72	1.85	0.40	1.64	0.36	0.09	0.40	0.05	0.36	0.08	0.21	0.03	0.16	0.03
98RME-0146	41.31	76.82	8.79	29.73	5.37	0.79	4.64	0.76	4.91	1.04	3.30	0.52	3.59	0.58
98RME-0152	35.86	69.61	8.42	29.90	5.50	0.87	4.71	0.77	4.87	0.99	2.88	0.44	2.88	0.45
98RME-0168	68.89	158.68	23.85	100.50	19.83	4.99	17.12	2.43	14.17	2.60	7.03	0.94	5.74	0.86
98RME-0171	3.37	7.33	1.22	6.60	2.39	0.92	3.45	0.64	4.26	0.98	2.76	0.42	2.72	0.42
98RME-0185	2.38	6.52	1.06	5.21	1.47	0.29	1.60	0.24	1.49	0.29	0.79	0.11	0.69	0.11
98RME-0231	18.93	41.88	5.83	23.18	4.50	1.14	3.77	0.63	3.98	0.82	2.38	0.38	2.42	0.38
98RME-0268	22.50	50.96	6.33	24.08	4.75	1.10	3.85	0.64	4.05	0.82	2.33	0.36	2.34	0.36
98RME-0294	51.66	118.28	17.73	78.98	16.65	5.39	14.97	2.07	11.37	2.09	5.52	0.67	3.99	0.57
98RME-0318	46.74	117.78	16.54	62.90	11.83	2.21	9.81	1.58	9.95	2.06	6.31	0.98	6.76	1.06

Appendix 1b. Chemical analyses of rocks from the Hinchinbrooke and Chippewa plutons from Wallach (1973).

Sample Name	Rock Type	SiO2	TiO2	Al2O3	Fe2O3*	MgO	CaO	Na2O	K2O	Total	Mg #
17-30-7-1	Hgrd	70.90	0.35	15.00	3.40	1.00	2.08	4.16	2.97	99.86	36.81
17-30-9-1	Hgrd	66.55	0.54	15.90	4.35	2.20	3.58	4.58	2.53	100.23	50.04
17-32-8-2A	Hgrda	70.40	0.29	15.90	3.25	0.98	3.47	5.16	1.20	100.65	37.39
17-136-5-1	Hgrd	64.75	0.39	17.40	3.60	0.86	6.13	4.54	0.93	98.60	32.12
17-136-6-3	Hgrd	69.80	0.32	15.55	2.42	0.58	4.21	4.33	2.10	99.31	32.19
17-136-6-4	Hgrd	70.20	0.27	15.00	2.45	0.62	4.41	4.07	1.73	98.75	33.39
17-138-1-1	Hgrd	69.00	0.28	16.40	2.75	1.06	3.43	4.67	1.96	99.55	43.29
17-138-1-3	Hgrd	70.40	0.29	16.60	2.42	0.40	4.43	4.17	2.34	101.05	24.66
17-138-4-5	Hgrd	69.50	0.28	16.00	2.13	0.30	4.76	4.48	2.20	99.65	21.81
17-138-5-2A	Hgrda	70.70	0.83	12.25	6.16	1.23	1.86	5.06	0.55	98.64	28.34
17-138-6-2A	Hgrda	69.75	0.43	15.40	4.30	0.82	2.70	5.51	0.91	99.82	27.41
17-138-9-1	Hgrd	77.00	0.23	13.00	2.19	0.17	1.95	4.75	1.31	100.60	13.32
17-140-2-5	Hgrd	67.10	0.49	15.75	4.69	2.18	5.03	4.54	1.75	101.53	47.93
17-140-2-8	Hgrd	63.50	0.52	16.80	4.91	1.80	4.25	4.47	2.19	98.44	42.06
17-140-4-2A	Hgrda	75.00	0.26	14.25	2.14	0.24	2.66	4.19	1.19	99.93	18.17
17-140-5-10	Hgrd	71.80	0.33	13.60	3.18	0.52	2.68	4.04	2.04	98.19	24.46
17-140-8-1A	Hgrda	73.15	0.31	14.98	3.15	0.43	2.75	3.93	2.18	100.88	21.28
18-39-4-11	Hgrd	66.20	0.55	16.38	3.93	0.65	5.48	4.90	1.28	99.37	24.67
18-39-9-1A	Hgrda	71.30	0.27	15.10	2.70	0.98	3.13	5.47	0.53	99.48	41.82
18-41-1-1	Hgrd	70.25	0.49	14.75	4.17	1.69	2.82	4.12	2.92	101.21	44.52
18-41-2-11	Hgrd	70.80	0.24	16.05	2.60	0.64	2.04	4.50	2.12	98.99	32.77
18-41-4-1	Hgrd	67.85	0.27	16.60	2.96	0.92	4.06	4.55	1.17	98.38	38.10
18-41-6-2	Hgrd	64.50	0.44	16.50	4.65	1.72	5.62	4.63	0.92	98.98	42.28
18-41-8-2	Hgrd	60.30	0.57	16.90	6.45	2.48	6.38	4.51	0.43	98.02	43.23
18-47-2-1A	Hgrda	64.75	0.80	17.15	6.10	0.78	3.97	5.14	1.12	99.81	20.21
18-47-2-10	Hgrd	74.50	0.29	13.50	3.09	0.75	2.70	3.70	2.36	100.89	32.46
18-47-5-10	Hgrd	65.20	0.53	16.20	4.53	1.71	4.61	4.84	1.45	99.07	42.78
18-47-7-17	Hgrd	68.30	0.55	15.50	5.55	1.35	4.52	4.14	0.47	100.38	32.51
18-47-8-4A	Hgrda	73.75	0.30	14.80	1.70	0.43	2.11	4.70	1.75	99.54	33.37
18-120-2-2	Hgrd	62.00	0.53	17.45	5.16	1.85	5.50	4.73	0.94	98.16	41.52
18-120-3-2	Hgrd	67.40	0.29	17.00	2.90	1.33	3.67	5.06	1.04	98.69	47.60
18-20-6-2	Hgrd	71.25	0.36	14.30	3.10	1.70	2.78	4.10	1.48	99.07	52.06
18-120-7-1	Hgrd	67.40	0.41	17.63	3.31	1.75	4.42	4.43	0.68	100.03	51.15
18-120-8-1	Hgrd	65.60	0.40	17.10	3.40	1.42	5.19	4.57	0.70	98.38	45.27
18-120-9-2	Hgns	73.25	0.30	13.50	1.90	0.65	1.70	3.38	4.18	98.86	40.39
18-122-2-3	Hgrd	65.20	0.43	16.80	4.35	1.32	5.42	4.58	0.60	98.70	37.54
18-124-2-3	Hgrd	67.00	0.34	17.65	3.40	0.78	5.12	4.76	0.63	99.68	31.24
18-124-8-1	Hgrd	68.30	0.50	15.90	2.90	0.30	5.02	4.48	1.03	98.43	17.00
DC1	Hgrt	72.00	0.49	13.70	3.45	0.60	1.70	2.73	5.21	99.88	25.62
DC2	Hgrt	71.80	0.54	14.20	3.95	0.35	1.87	3.66	3.74	100.11	14.93
S-1	Hgrd	70.00	0.24	15.50	2.58	0.87	3.53	4.53	1.65	98.90	40.04
S5A	Hgrda	74.60	0.17	15.00	1.23	0.36	1.77	4.84	3.13	101.10	36.69

Abbreviations: Hgrd = Hinchinbrooke gneissic granodiorite; Hgrda = Hinchinbrooke anomalous gneiss granodiorite (i.e., high in Si & Na, low in K); Hgrt = Hinchinbrooke gneissic granite; Hgns = Hinchinbrooke gneiss; EC = Enterprise Complex (i.e., Chippewa pluton).

Appendix 1b. continued.

Sample Name	Rock Type	SiO2	TiO2	Al2O3	Fe2O3*	MgO	CaO	Na2O	K2O	Total	Mg #
S14A	Hgrda	73.00	0.20	16.00	2.30	0.60	2.88	5.66	0.97	101.61	34.06
SE3	Hgrd	66.20	0.93	14.78	5.46	1.60	4.39	4.00	1.42	98.78	36.72
SE6	Hgrd	70.50	0.23	14.90	2.29	0.72	3.05	4.29	2.32	98.30	38.37
T1a	Hgrd	69.20	0.77	15.10	4.72	1.35	2.69	4.24	1.62	99.69	36.16
T1b	Hgrt	71.75	0.69	14.30	4.20	1.38	1.99	3.62	3.92	101.85	39.42
T5	Hgrd	64.50	0.55	16.50	5.21	2.35	3.68	4.89	1.34	99.02	47.18
T6A	Hgrda	76.20	0.27	13.20	3.02	0.35	1.19	5.20	1.27	100.70	18.67
T7	Hgrd	59.60	0.60	17.42	6.24	2.42	6.61	4.28	0.71	97.88	43.44
T8	Hgrt	70.75	0.63	13.50	4.37	1.68	1.45	2.77	4.81	99.96	43.23
T9	Hgrt	70.30	0.50	14.10	3.86	0.35	1.60	3.45	4.30	98.46	15.22
T10a	Hgrd	67.25	0.30	15.75	2.75	1.50	4.05	4.34	1.22	97.16	51.93
T12	Hgrd	69.00	0.18	17.15	1.09	0.25	3.17	5.25	2.19	98.28	31.23
T14-1	Hgrd	58.60	0.66	19.00	6.00	1.68	6.20	4.98	0.92	98.04	35.67
T15	Hgrd	67.30	0.37	15.60	3.98	1.40	3.95	4.53	1.93	99.06	41.06
T16	Hgrt	71.40	0.65	13.00	4.11	0.74	1.48	3.30	4.09	98.77	26.28
T17	Hgrt	70.75	0.58	14.70	3.90	0.47	1.93	4.09	3.99	100.41	19.27
T18A	Hgrda	73.50	0.29	13.12	3.56	0.68	1.63	4.53	1.80	99.11	27.45
T19	Hgrd	66.90	0.60	14.36	5.18	1.90	2.78	4.04	2.18	97.94	42.08
T20	Hgrd	69.10	0.27	15.65	3.20	1.22	3.16	4.48	1.34	98.42	43.02
TW2	Hgrd	68.30	0.33	16.20	2.88	0.82	4.88	4.64	1.45	99.50	36.06
TW4	Hgrd	70.60	0.20	17.25	2.05	0.34	4.42	5.04	1.07	100.97	24.72
TW4A	Hgrda	68.30	0.38	15.40	3.36	0.92	4.59	4.46	1.11	98.52	35.16
TW8	Hgrd	69.30	0.54	13.00	6.66	0.74	2.77	4.40	0.92	98.33	18.04
TW9	Hgrd	71.25	0.23	15.00	1.76	0.40	2.31	4.45	2.82	98.22	31.04
TW18	Hgrd	62.30	0.83	15.55	5.47	1.28	5.62	5.10	1.41	97.56	31.67
TW22	Hgrd	70.70	0.20	15.64	1.76	0.49	4.23	4.69	0.53	98.24	35.54
TW24	Hgrd	69.00	0.32	16.05	3.25	0.86	4.57	4.77	0.69	99.51	34.39
TW25	Hgrd	67.20	0.42	15.50	2.76	0.80	5.10	4.52	1.04	97.34	36.47
TW26	Hgrd	71.00	0.18	15.52	1.91	0.49	3.32	4.77	1.75	98.94	33.69
TW27	Hgrd	68.50	0.35	15.63	4.03	1.11	3.53	4.96	1.13	99.24	35.29
TW29	Hgrd	69.30	0.30	15.50	3.58	1.91	2.77	4.21	0.89	98.46	51.38
WE54	Hgrd	68.65	0.24	15.50	2.67	0.87	3.72	4.31	1.65	97.61	39.22
WE57	Hgrd	69.90	0.42	14.35	4.48	1.28	4.12	4.19	0.56	99.30	36.14
WE60	Hgrd	69.85	0.23	15.08	1.71	0.30	3.80	4.74	1.27	96.98	25.79
S4	EC	78.00	0.15	12.60	1.02	0.20	0.73	3.66	4.97	101.33	27.97
S9	EC	56.00	1.54	17.30	8.40	2.05	5.31	5.48	2.55	98.63	32.58
TW3B	EC	55.75	1.58	18.60	7.33	1.30	4.96	5.64	3.35	98.51	25.99
TW13	EC	60.60	1.13	17.00	5.70	1.40	2.83	5.69	4.64	98.99	32.72
TW17	EC	74.10	0.28	12.50	1.38	0.00	1.23	3.44	5.66	98.59	0.00
Tw20	EC	57.50	1.36	17.50	7.35	1.66	4.43	6.86	3.93	100.59	30.90
Tw28	EC	50.30	1.65	18.95	10.30	3.10	8.43	4.36	1.05	98.14	37.35
Tw32	EC	54.95	1.55	19.25	6.31	2.13	5.45	6.07	2.24	97.95	40.07

Abbreviations: Hgrd = Hinchinbrooke gneissic granodiorite; Hgrda = Hinchinbrooke anomalous gneiss granodiorite (i.e., high in Si & Na, low in K); Hgrt = Hinchinbrooke gneissic granite; Hgns = Hinchinbrooke gneiss; EC = Enterprise Complex (i.e., Chippewa pluton).

Metric Conversion Table

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
		LENGTH			
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
		AREA			
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
		VOLUME			
1 cm^3	0.061 023	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.307 951	cubic yards	1 cubic yard	0.764 554 86	m^3
		CAPACITY			
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
		MASS			
1 g	0.035 273 962	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 747	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 622 6	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311 3	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 90**	t
		CONCENTRATION			
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

	Multiplied by	
1 ounce (troy) per ton (short)	31.103 477	grams per ton (short)
1 gram per ton (short)	0.032 151	ounces (troy) per ton (short)
1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in co-operation with the Coal Association of Canada.

ISSN 0826-9580
ISBN 0-7794-1495-0